

where it has been found, (1) in the Waipio railroad cut, (2) between the middle and westerly lochs of the harbor and (3) on Ford Island—all of which localities lie within a radius of about five miles.

In the year 1926 in a sand pit excavation at the spur between Manoa and Palolo valleys an oyster conglomerate containing shells in abundance of this species was found associated with beach shells of the species now living. This was the innermost marine deposit on this part of the island and about two miles from the present shore line. This site is about 15 miles in linear measurement from the type locality of Waipio and the age appears to be late Pleistocene.

A NOTE ON THE FOSSIL MARINE FAUNA DREDGED FROM THE JAPANESE SEAS

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The marine fauna inhabiting the seas surrounding Japan is gradually becoming well known through the extensive dredge operation and other oceanographical observations made by the *S.S. Sôyô-Maru* of the Imperial Fisheries Experimental Station at Tôkyô Fisheries Experimental Station at Tôkyô, the *SS. Hukui-Maru* of the Hukui Prefectural Fisheries Station, besides many other local fisheries stations, biological institutions, etc. However, although we have considerable knowledge, there remains much more room for further knowledge concerning the marine fauna of our waters.

Recently, this necessity for more knowledge was strongly felt as a result of many fossils being dredged from the seas of certain parts of Japan. Without further dredgings in shallow seas, we cannot expect to gain a full knowledge of our fauna.

In the present report we wish merely to state some of the interesting fossils known from the seas bordering Japan on the one hand and to state some of the interesting problems now facing us in this subject.

According to H. G. Richards,¹ the marine shells found on the "Banks" of North Carolina, comprise a fauna consisting of a large percentage of shells that appeared to be fossil. He says, "Many were very worn; others were black in color and resembled those often found on the New Jersey beaches and which were considered as having been washed from some nearby Pleistocene deposit."

The presence of certain Pliocene species on the "Banks" is explained by him as "The Pliocene (Waccamaw formation) is probably not very deeply buried near the shore line and it may form the sea bottom some miles off shore," and that the Pleistocene (Pamlico formation) probably extends seaward, dipping beneath the recent deposits of the sea floor. From the geographic distribution of the species collected, their state of preservation, relation to the geological formation of the adjoining district and mixed characters of the fauna, Richards concludes that "While it is undoubtedly true that many warm water species do occur near Cape Hatteras, it is probably that some of these records are based upon Pleistocene fossils found on the beaches," and that "it is desirable that living specimens be obtained when recording a new northern or southern limit for a species."

A questionable record for *Panomya arctica* Lamarck is given by R. A. McClean.² According to him, *P. arctica* was dredged dead from a newly charted canyon on the south side of George's Bank in 290–328 fathoms (40 21 N. 67 50 W). The known bathymetric range for this species is said to be 25–115 fathoms; thus the present record either extends the known range in depth or it was carried to this depth by a landslide of the substratum. However, H. Stetson is of the opinion that the recent mud in which it was found "rests on a clay, possibly Tertiary in age, which occurred at a comparable depth in another canyon."

It is hard to decide whether the dead shell obtained by them is a fossil or a recent one. Both authors have logical views, probably future dredgings will settle this problem.

W. H. Dall³ records Upper Cretaceous fossils from the sea bot-

¹ H. G. RICHARDS; Some Shells from the North Carolina "Banks," NAUTILUS, 49(4), 130–134, 1936.

² R. A. MCCLEAN; *Panomya arctica* Lamarck, NAUTILUS, 49(1), 34–35, 1935.

³ W. H. DALL; Tertiary Fossils Dredged off the Northeastern Coast of North America, Contr. Pal. Lab., Peabody Mus., published in Amer. Jour. Sci., 10, 213–218, 1925.

tom of a depth of 200 fathoms off Banquereau, Nova Scotia; questionable Eocene fossils from George's Bank; Miocene, questionable Miocene, Pliocene, questionable Pliocene, and questionable Pleistocene fossil mollusca from the sea bottom of George's Bank.

Probably other such records are also found in literature of various countries. Probably more noteworthy than the records of fossils dredged in foreign waters is the profound fact that the Japanese waters, especially that of the Japan Sea, yields a large number of fossil vertebrates. In the following lines the records of some fossil marine animals are briefly given.

H. Niino⁴ records from the sea bottom of the Tyôsen Strait the following species of fossils, namely: *Corbis civica* Yokoyama from depths of 73, 146 and 139 meters; *Pecten intuscostatus* Yokoyama from depths of 90, 99, 112, 139, 192, and 219 meters; *Pecten heteroglyptus* Yokoyama from 139 meters; *Poromya flexuosa* Yokoyama from 90 meters; *Thyasira bisecta* Conrad from 194 and 249 meters; *Lora yamanii* Yokoyama from 100 meters; *Turricula subdeclivis* Yokoyama and *Turbonilla morsei* Yokoyama from 130 meters; and *Carcharius cuspidatus* (Agassiz) from 249 meters.

Of the fossils just mentioned, *Pecten heteroglyptus* is a characteristic Pliocene fossil first appearing in the Lower Miocene of Japan, extending its range upward to the Middle Pliocene. *Thyasira bisecta* is found in the Oligocene, Miocene and Pliocene of Japan where it makes several distinct faunal horizons of wide distribution; it is not yet known to be living in the waters surrounding Japan, although an isolated broken valve is reported from the Strait of Tyôsen (Korea). *Carcharius cuspidatus* is frequently met with in the Miocene of Japan.

Fossil marine mollusca, brachiopoda, foraminifera, diatoms and sponge spicules are widely distributed in the sea bottom of the Japan Sea,⁵ extending from Hokkaidô at the north to the Strait

⁴ H. NIINO; Fossil Localities in the Sea Bottom of the Tyôsen (Korea) Strait, Jour. Geol. Soc. Jap., 46(546), 383-386, 1 pl., 1934 (Japanese).

⁵ H. NIINO; On the Discovery of *Thyasira bisecta* CONRAD in the Sea Bottom of the Tyôsen Strait, Jour. Geol. Soc. Japan 41(487), 176-182, 1934 (Japanese). Ditto, Bottom Material of Western Tugaru Strait, *ibid.*, 41(495), 713-726, 1934 (Japanese). Ditto, On Soundings at Musasi-tai, Geogr. Rev. Japan, 12(2), 85-95, 1936 (Japanese). Ditto, On Soundings from the Banks between the Oga Peninsula and Sado Island in the Northeastern Part of the Japan Sea, Jour. Imp. Fisher. Inst., 31(1), 1935.

of Tyôsen at the south. Even the existence of a submerged forest is reported by M. Shimakura⁶ at Uodu in Toyama prefecture. According to him, from the 90 samples of fossil woods from the submerged forest, "the submerged forest may be considered to be analogous to those now living in the southern part of the Temperate regions of Japan," and that "The forest, if it were in Akita district, grew on an eminence of more than 100 m. above the sea level."

The single dorsal valve of *Coptothyris grayi* (Davidson),⁷ a brachiopod, once recorded from off Arakawa, Tiba Prefecture, in 23 meters, has the appearance of being a fossil. And now with other data at hand, we are of the opinion that it really is a fossil. From the same station was also found a single valve of *Pecten swiftii* Bernardi, encrusted with bryozoa on the inner side of the valve and with a solitary coral adhered to its outside; this also appears to be a real fossil. Further, soft gravels of calcareous sandy shale or calcareous fine sandstone containing fossil foraminifera belonging to *Quinqueloculina lamarckiana* d'Orbigny, *Globigerina inflata* d'Orbigny and *Eponides haigenbergii* d'Orbigny was recorded from the Banks of Senoumi in Suruga Bay by H. Niino.⁸

Besides the many fossil molluscan shells which are dredged from the sea bottom of the Japan Sea, there are also many fossil woods, brachiopoda, plant leaves, foraminifera with the probability of finding fossil corals and other preservable marine invertebrate animals. The fossil plant leaves once mentioned by H. NIINO are of considerable interest in the fact that closely similar ones are known from the Neogene Tertiary deposits of the adjacent region.

Of the many kinds of marine animals which are supposed to be fossils, probably the foraminifera present the most interesting and difficult problems. Firstly, because they are easily carried

⁶ M. SHIMAKURA; On the Woods of the Submerged Forest of Uodu, Toyama-Ken, Japan, Sci. Rep. Tôhoku Imp. Univ., Geol., 18(3), 299-310, 1936.

⁷ K. HATAI; A List of the Recent Brachiopoda Dredged from the Littoral Sea of the Pacific Side of Bôsô Peninsula, Central Japan, Rec. Ocean. Wk. Jap., 8(1), 1-17, 1936.

⁸ H. NIINO; On the Soundings from the Banks of Senoumi in the Bay of Suruga, Japan, Jour. Imp. Fisher. Inst., 29(2), 69-91, 3 pls., 1934.

from the original place of habitat by waves, currents and other such oceanographical phenomena, or by landslides or submarine disturbances, to either deep water where they did not live or to shallower water. Secondly, since their living parts have not yet been discovered in the material dredged from the sea bottom of the Japan Sea, it is difficult to prove their existence in that region. Thirdly, merely the presence of polished shells, fresh appearance and mode of preservation are not sufficient data to prove their existence in that region, due to the fact that the Pliocene Byôritu Beds of Taiwan (Formosa), the Pleistocene Ryûkyû limestone formation of Kikai-zima in the Ryûkyû Island Ground, and several other localities in the Kwantô Region of Central Japan, yield fossil molluscan shells in such perfect preservation that not only the minutest detail of the sculpture is retained but also the original coloration is very often preserved; in fact, a large number of them are in a state of preservation exceeding those now found strewn along the beaches. Fourthly, because their soft parts are hard to obtain, even although there are reports dealing with the living foraminifera. Such minute creatures are easily carried to and fro by agencies including winds.

In fact, H. Niino⁹ reported the occurrence of fossil foraminifera from Tosabae, a marine bank situated at the entrance of Kii Strait, 50 km. off the coast of Cape Muroto, Tosa Province, Sikoku, Japan. The rocks building up the bank are apparently the same as those building up the Neogene formation developed in Aki-gun, near Cape Muroto, where fossil foraminifera and mollusca are known to occur.¹⁰ The description given by H. Niino brings to mind the "Banks" of North Carolina mentioned by Richards, although the Japanese one is submerged while the American one is above sea-level. If the relation between the bank and the mainland mentioned by Niino is similar to that of the North Carolina "Banks" to the mainland, *i.e.*, geologically, then it may be possible that we shall be able to find some fossil shells washed out from the Pliocene deposits of the coasts of near Cape Muroto in the recent fauna found strewn along the beaches

⁹ H. NIINO; On the Soundings at Tosabae, *Geogr. Rev. Japan*, 11(8), 679-687, 2 pls., 1935 (Japanese with English resume).

¹⁰ M. YOKOYAMA; Pliocene Shells from Tonohama, Tosa, *Rep. Imp. Geol. Surv. Japan*, 104, 9-17, 2 pls., 1929.

of Tosa Bay. This possibility is very great and probably we shall yet hear of records of fossils in the recent fauna there.

The very interesting article by W. H. TWENHOFEL¹¹ dealing with the problem of environment in sedimentation and stratigraphy, is of much value in dealing with the problem stated above, and without full consideration of his article, we believe that the palaeontologist as well as biologist will not arrive at accurate results in analyzing a marine fauna of doubtful fossils intermingled. Furthermore, in order to deal with the problem of palaeo-ecological conditions, difference in geographic distribution of living and fossil forms, or evolution of climatological conditions, we sincerely believe, and take this opportunity to state, that the four phases of environment as discussed by W. H. Twenhofel are not only most important, but should also be studied in the field¹² to the extent possible, to bring about conclusions worthy of scientific recognition. Mere assumptions without any sufficient data is not only a bad means of study but also one that does more harm than good.

The presence of fossils in the Japan Sea bottom is of interest not only from the view of the palaeontologist but also from that of the geologist. We have already submitted¹³ a short note on the possible explanations to the fossil fauna of the Japan Sea. In short, we believe that the fossils are really those of the Pliocene Daisyaka Shell-beds which are widely distributed in Mutu province, a part of Northwest Ugo province, and in Sado Island, but not on the intermediate adjacent districts. The limited distribution in the region south of Oga Peninsula, its occurrence on Sado Island, wide distribution north of Oga Peninsula, together with the submarine topography and general distribution of the fossils in the Japan Sea lead us to believing that the fossils belong to no other than the Pliocene Daisyaka Shell-beds. These beds overlie the next older, Natukawa Shell-beds of Lower Pliocene

¹¹ W. H. TWENHOFEL; *Environment in Sedimentation and Stratigraphy*, Bull. Geol. Soc. America, 42, 407-424, 1931.

¹² In regard to studies in the field relating to this subject, one of our papers is now in press; it is entitled "The Geologic Significance of the Recent Mollusca from Nagahama, near Isnomaki, Rikuzen Province, Japan." In it the four phases mentioned by W. H. TWENHOFEL are carefully studied and good examples are found in the field.

¹³ To be published in *Records of Oceanographic Works in Japan*, 1937.

age; this latter mentioned beds cover extensive area in the region south of Oga Peninsula. Thus it seems that the presence of fossils in the Japan Sea and especially if they really belong to the Daisyaka Shell-beds are important data in dealing with the history of the Japan Sea on the one hand and form a basis of interesting comparative study of the marine fauna which consists of both living and fossil animals.

THE OCCURRENCE OF TETHYS WILLCOXI IN NEW ENGLAND WATERS, AND ANOTHER RECORD FOR THIS LOCALITY

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Tethys willcoxi was originally described by Heilprin (1886) from Florida, and the members of this genus are most commonly found in tropical waters on the Atlantic coast. But there are occasional records of the species, *willcoxi*, from New England. These records are, however, comparatively rare, and in most cases consist of only one specimen. This fact indicates that the species can hardly be considered indigenous to that section of the coast, and it is more likely that its infrequent occurrence in the region is best accounted for by the proximity of the Gulf Stream. Thus in the Woods Hole and Marthas Vineyard area, where this current passes close by, and on which it may encroach more at certain seasons and in different years than in others, are found various tropical organisms which are completely out of their usual range and yet are carried there or materially assisted in their progress by the Gulf Stream. Tropical forms in northern waters but some distance away from the Woods Hole region are more difficult to account for. It must be assumed that individuals of this kind reached these latitudes with the aid of the Gulf Stream, and that they then migrated by themselves through abnormally cold waters or were perhaps helped along by smaller currents, so that they eventually arrived in such a locality. The present record for *Tethys willcoxi* is one of the few which belongs to this latter type.